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COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

APPLICATIONS OF SPACE COMMUNICATIONS TECHNOLOGY TO DISTANCE EDUCATION

Note by the Secretariat

1. The Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), in the report on the work of its eighth session, proposed that a few more specific space applications studies should be carried out to demonstrate the potential of space technology. The Working Group identified a number of possible subjects for such studies, including the development of distance education programmes (A/AC.105/571, annex II, para. 17 (c)).

2. The present study has been prepared by the Secretariat in response to the request of the Working Group of the Whole. Its purpose is to review the applications of space communications technology for distance education as well as the experience of a number of countries in implementing distance education projects, and is intended primarily for the benefit of countries that have not yet used space technology for this purpose but are interested in its potential benefits. The study was prepared using a variety of national and international sources listed in the selected bibliography at the end of the study. The following summary of the study appears in all the official languages of the United Nations. The full study, contained in the annex to the present note, is being distributed only in the language in which it was prepared (English).

SUMMARY OF THE STUDY

3. Education is extremely critical for sustainable development, economic growth and poverty reduction. Changing technologies and economic reforms are creating dramatic shifts in the structure of economies, industries and labour markets throughout the world. These developments have created three key priorities for education: (i) it must be accessible for all; (ii) it must support the continued expansion of knowledge; and (iii) it must meet growing demands by the market place for adaptable workers who can readily acquire new skills.

4. Problems of access to educational opportunities is especially crucial in developing countries, which account for about 75 per cent of the world population. If the current high population growth rates in Africa,

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South Asia and the Middle East and north Africa continue, the number of 6-to-11-year-old children not attending schools will increase to 162 million by the year 2015, from 129 million in 1990. To make the matter worse, only two thirds of children who start primary school complete it. As a result, adult illiteracy, which already affects over 900 million people, most of them in developing countries, is likely to remain a major problem.

5. Traditional means of education are not fully adequate to meet the needs of large populations for lifelong learning, even in rich countries. In developing countries, education for all, at least past the primary level, looks like an unrealistic dream if only conventional strategies are pursued. The development of distance education programmes offers a very promising way to meet the educational needs of millions of children and adults, especially in developing countries where expertise and physical and financial resources are limited and the bulk of the population lives and works in rural or remote areas.

6. The latest trends show that universities in both industrialized and developing countries have started programmes oriented to geographically dispersed students. The number of these programmes has grown very rapidly in order to meet the increasing demand for flexible lifelong learning available for all. According to the International Centre for Distance Learning (ICDL) of the Open University of the United Kingdom of Great Britain and Northern Ireland, there are currently about 30,000 distance courses and programmes offered by institutions in the countries of the Commonwealth and about 850 distance teaching institutions worldwide.

7. Traditionally, text-based correspondence courses have been the primary means for delivering distance education both in industrialized and in developing countries. In the last three decades, the rapid development of space technology has made satellite communications systems very efficient in delivering distance education programmes, especially to remote and rural areas that otherwise have been outside the reach of both traditional communications networks and conventional education systems.

8. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), held at Vienna in 1982, considered the implications of satellite communications technology, in particular, direct broadcasting satellite technology, which was a primary means of delivering instructional television (ITV) programmes for educational purposes and the possibility of regional or international cooperation. UNISPACE 82 noted the requirements in developing countries to improve the educational infrastructure, not only to educate the young, but also to provide a continuing source of information, knowledge and know-how to the adult population. While the use of space technology does not provide instant solutions to these problems, it could complement conventional methods, accelerate the spread of education and improve its quality, particularly in remote and rural areas.

9. Developments in satellite-based telecommunications networks, information and digital technologies, as well as the convergence of telecommunications and computers, have been decreasing the cost of storing, processing and transmitting information by 50 per cent every 18 months. In addition to ITV programmes, these developments are providing educators with powerful tools to establish reliable, multisite, two-way interaction with students in order to facilitate learning, maintain motivation and ensure steady progress via electronic distance education (EDE). This has led to a paradigm shift regarding education access, whereby education goes to the people rather than having people going to the schools or universities.

10. In the United States, experiments with ITV programmes were initiated as early as the beginning of the 1950s using both broadcast and closed-circuit television. Evaluation of these early experimental programmes showed that the technology was equally effective compared to conventional face-to-face means of instruction. An obvious advantage of ITV was that it could bring educational opportunities to students in rural and remote areas where qualified teachers in many disciplines were not available. In the 1970s, the experimental application

technology satellite (ATS-6) was used to deliver ITV programmes to remote and rural areas in the Appalachian and Rocky Mountain regions and to the State of Alaska.

11. In the 1980s, the positive results of the ATS-6 experiment led a number of States, mostly those with large territories and low population densities, to establish State educational satellite networks. Many universities started distance education programmes using ITV as the primary means for programming delivery and designed to deliver both general educational programmes to rural schools and colleges and to offer accredited graduate and undergraduate degree courses to off-campus students. As satellite communications technology has evolved, colleges and universities in the United States of America are becoming increasingly tied together in satellite video networks. Since the early 1980s, a number of networks have been established in North America to produce special ITV educational programmes, or to share courses among all or some of the estimated 2,000 higher-educational institutions that are equipped with satellite television receiving stations.

12. In India, the satellite instructional television experiment (SITE), using the United States ATS-6 satellite stationed over the Indian Ocean, was carried out from 1975 to 1976. The satellite for this experiment was provided by the National Aeronautics and Space Administration (NASA) and the ground segment was designed and manufactured by the Indian Space Research Organization (ISRO) working in collaboration with All India Radio/Doordarshan. ITV programmes produced domestically were broadcast from Earth stations in Ahmedabad and Delhi via ATS-6. These programmes were received in 2,400 villages in several Indian states using specially designed three-metre parabolic antennas, front-end converters and television sets. The SITE programme clearly demonstrated that India had the technical and organizational expertise to control and operate a satellite, to build, maintain and operate ground control stations and direct reception systems, to produce enough educational programming to feed the system and to keep the whole system functioning smoothly in both urban and rural areas.

13. The success of the SITE experiment has led to the establishment of the Central Institute of Educational Technology (CIET) and six State Institutes of Educational Technology (SIETs) which use the Indian National Satellite System for Television and Telecommunications (INSAT) to run satellite-based ITV programmes. Currently, this service regularly provides 45 minutes of educational programmes for children of different age groups and for teachers in each of the five regional languages. In order to fully utilize the capabilities of satellite-based ITV, ISRO is developing a new concept of a dedicated satellite mission known as GRAMSAT to deliver ITV programmes as well as cultural and health information to both rural and urban areas all over the country in each of the regional languages.

14. In Brazil, the ITV *Telecurso 2000* project was initiated at the beginning of 1995 and is providing primary, secondary and vocational ITV-based education targeted to the approximately 50 million people who dropped out of or never entered the formal educational system of Brazil. One of the key elements of the project is the extensive use of so-called telesalas–special training rooms with television monitors and teaching assistance available at community centres, churches, large factories and prisons. It is broadcast by the Globo Television network before the popular "Good Morning, Brazil" programme, rebroadcast during the day on educational networks and supported by print materials available at news-stands throughout the country.

15. In China, the Central Radio and Television University (CRTVU) runs multimedia distance higher education courses using radio, instructional television, print-based and audiovisual teaching materials. This modern distance education system is made up of CRTVU, 43 provincial, autonomous regional and municipal television universities, 654 branch schools at the prefecture and city level, 1,500 work stations at the county level and more than 10,000 teaching classes that cover rural and urban areas of China. While initially using the microwave network of China Central Television, the entire Chinese distance education system centred on CRTVU now uses Chinese communications satellites capable of reaching all of China plus neighbouring countries in eastern, central and south-east Asia.

16. Prior to the establishment of an operational domestic satellite communications network capable of nationwide delivery of ITV programmes, China carried out a distance education pilot project in 1985 using a satellite transponder provided free of charge by the International Telecommunications Satellite Organization (INTELSAT) within the framework of its Satellites for Health and Rural Education (SHARE) programme. As a result, 53 small Earth stations were installed in remote and rural areas of China to receive ITV programmes and for rebroadcast for local reception. Transmitted ITV programmes included advanced academic courses in various disciplines broadcast six hours each day, as well as more diverse educational materials such as lectures on calligraphy, oriental fine arts and health care. The pilot project proved to be very successful both in terms of educational achievements and cost-efficiency, and it led to the establishment of an operational full-scale nationwide China Educational Television (CETV) network that relies on a domestic communications satellite and two satellite transponders leased from INTELSAT.

17. In Australia, a number of states use satellite ITV on an operational basis to deliver educational programmes to primary and secondary schools located in rural and remote areas. By the end of 1994, 170 rural schools in the State of Victoria were equipped with small receiving terminals, at an average cost of 1,700 Australian dollars per site. The equipment provides two-way, interactive communications between the classroom and the remote central studio. The Education Department of Western Australia uses the government-sponsored Westlink service to deliver state-wide ITV programmes produced by the Education Interactive Television Centre at Leederville. The Westlink service allows the distribution of teaching and learning programmes at a fraction of the normal commercial cost associated with satellite transmission. Programmes are transmitted for four hours each week using a satellite system that provides for a one-way broadband video system with an audio return path.

18. In 1981, Indonesia started the Indonesian Distance Education Satellite System (SISDIKSAT) project linking 15 distant universities in the eastern part of Indonesia. An open interactive audioconferencing network was established on the basis of the Palapa satellite communications system to deliver academic courses to university students, upgrade faculty skills through in-service training programmes and facilitate administrative and institutional communication. It also made available the expert resources of each institution to all members of the network, thus multiplying each professional's outreach and effectiveness. A variety of educational programmes was delivered to all members of the network, including 60 academic courses and over 30 seminars. More than 10,000 students benefited from these interactive programmes and other services offered by SISDIKSAT.

19. As a follow-up to project SHARE, the Project Access programme was established by INTELSAT to provide free satellite capacity, for a limited duration, for education and health care. One of the latest activities under the Project Access mandate is the establishment of a pilot "Distance Education and Training Network of the Americas". The pilot network to be designed by INTELSAT, with the assistance of the National Education Telecommunications Organization/Education Satellite (NETO/EDSAT), will benefit students in rural and remote areas of the United States and other countries in the Americas, as well as serve as a model for establishing similar networks in developing and industrialized countries and lead to the development of a full-time, self-sustaining global distance education network.

20. Experimental and operational programmes and projects in distance education carried out by many countries have shown that satellite communications technology is well developed and can be successfully applied to distance education by both developing and industrialized countries. Numerous evaluation studies have demonstrated that ITV is capable of delivering information and developing skills in many disciplines with effectiveness comparable to, and in some cases exceeding, conventional educational systems.

21. In recent years, the rapid development of new information technologies, especially telematics (the intersection of informatics and telecommunications), has affected virtually every sector of economic, social and

political development. The technological changes have led to decreased costs in hardware and software for storing, processing and transmitting information, increasing miniaturization, portability and diversity of information-processing and communication equipment, and the capability to present and manipulate information in all media–data, text, voice, image and video–in ways that increasingly match individual preferences and cognitive styles.

22. The convergence of telecommunications, computers, satellites and fibre-optics technologies is critical to the knowledge-based economy of the future. This convergence also promises to make the knowledge base of humanity available anywhere, any time, in any language, at cost-effective prices and in an interactive format. Networked electronic distance education (EDE) emphasizes two-way interactivity via on-line information access and virtual classrooms. Because of the global, borderless nature of electronic networks and their fast delivery of information, networked education can enhance the whole spectrum of the educational experience, including the effective use of educational resources worldwide, improved student-teacher interaction, the opportunity for students to contribute to the development of course materials and information-sharing between educators and researchers.

23. The Internet has been used increasingly in the last few years to deliver educational material and distance education programmes in both industrialized and developing countries. Internet-based learning allows students to learn at their own pace and access the information at a convenient time, and provides education to remote students who otherwise would not be able to travel to a classroom. Some courses available on the Internet are delivered as a formal programme complementing regular meetings between students and teachers in the classroom. A large number of institutions offer on-line courses through the Internet in a wide range of disciplines and topics that can lead to diplomas or formal accredited degrees. Other Internet sites offer informal education at no charge on topics ranging from an interactive medical tutorial on the spinal cord and text books on chemistry, mathematics and physics, to learning languages such as Japanese, German and English and include an educational site on archaeology.

24. A large number of projects in the development of national and international distance learning infrastructures have been carried out in various countries. Since 1993, Canada has been working on design and implementation of a national Internet-based educational network called Canada's SchoolNet. Japan is developing the Asia-Pacific Interactive Communication Network (APICNET) for international cooperation, international cultural exchange and education aimed at creating a global classroom on the Internet. Since 1993, the Ministry of Education in Chile has been developing an educational network connecting more than 100 elementary schools in rural and remote areas. In Australia, the Queensland Open Learning Network (QOLN) was initiated by the government of the State of Queensland in 1990 in order to establish a State-wide delivery system for education and training using interactive communications technologies. The European Schools Project (ESP) was begun in 1988 to explore educational applications of telematics, and in Ghana, a SchoolNet project was started at the beginning of 1996 with the immediate goal of connecting 50 secondary schools and providing them with Internet access.

25. These and many other projects have shown that network-based delivery of education programmes provide many benefits to both the remote student and the educational institution. But owing to the relatively short period of time that on-line EDE programmes have been used, a complete evaluation of the role networked distance education plays in the formal education system as well as the effectiveness of the EDE methodologies is very difficult. However, the growing number of institutions offering networked EDE programmes and the widening range of educational disciplines and topics available on-line reflect the fact that networked distance education has already become an integral part of the current educational environment. This trend is supported by the declining cost and increasing capacity of the required hardware and software as well as by the declining cost of communications.

26. In the last few years, developing countries have spent a great deal of effort to overcome their existing communications problems and to join global electronic networks in order to enhance national educational and scientific capabilities. Satellite communications systems have been used by many countries to develop cost-effective networking solutions. A number of projects carried out by such organizations as HealthNet and Volunteers in Technical Assistance (VITA) proved that access to e-mail arranged through communications satellites could provide a low-cost and reliable means of delivery of educational programmes to remote and rural areas in developing countries.

27. The Office for Outer Space Affairs (OOSA), within the framework of the United Nations Programme on Space Applications, is working in cooperation with the European Space Agency (ESA) on a project proposal aimed at establishing a cooperative information network linking scientists, educators, professionals and decision makers in Africa (COPINE). When operational, COPINE would be a satellite-based information exchange network with interactive capability linking urban and rural centres in 13 African countries and selected hospitals, universities and information centres in Europe. The wideband capabilities of COPINE will be used to provide a variety of information delivery services, particularly computer file transfer, interactive data exchange and audio, image and video transmission, in order to facilitate projects in health care, distance education, scientific and technical information exchange and natural resource and environment management. After initial testing in Africa, this project may be eventually extended to cover other regions of the world.

28. Following the worldwide trend of establishing National Information Infrastructures (NII) and their integration into the Global Information Infrastructure (GII), virtually all developing countries have started working on the development of high-performance computer networks that link national universities, schools, libraries and research centres and are capable of facilitating high-speed Internet data access and retrieval. In many cases these projects are carried out as regional or international efforts. A number of projects carried out by the developing countries, and discussed in the study, aim at establishing educational computer networks using a combination of satellites, terrestrial lines and microwave links.

29. The development of telecommunications systems and new information technologies has made distance education, and in particular interactive ITV and EDE, as effective as traditional instruction, if the methods and technologies used are appropriate to the instructional tasks. From a technical point of view, satellite communications systems provide educators with reliable and powerful means for delivery of ITV and EDE programmes, and give learners, especially in remote and rural areas, opportunities to access desired education programmes, which otherwise are not locally available. The technologies are in place and their feasibility has been demonstrated in numerous projects carried out on a national or international scale. Further convergence of computing, telecommunications and television will make it possible to provide all three services over a single network in the near future.

*Annex**

APPLICATIONS OF SPACE COMMUNICATIONS TECHNOLOGY TO DISTANCE EDUCATION

Study by the Secretariat

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INTRODUCTION

1. Education is extremely critical for sustainable development, economic growth and poverty reduction. Changing technologies and economic reforms are creating dramatic shifts in the structure of economies, industries and labour markets throughout the world. This rapid increase in knowledge and the pace of changing technology raise the possibility that individuals, through frequent job changes, may acquire sustained economic growth. These developments have created three key priorities for education: (i) it must be accessible for all; (ii) it must support the continued expansion of knowledge; and (iii) it must meet growing demands by the market place for adaptable workers who can readily acquire new skills.

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*The present study has not been edited.

2. Problems of access to educational opportunities is especially crucial in developing countries, which account for about 75 per cent of the world population. If the current high population growth rates in Africa, South Asia and the Middle East and north Africa continue, the number of 6-to-11-year-old children not attending schools will increase to 162 million by the year 2015, from 129 million in 1990. To make the matter worse, only two thirds of children who start primary school complete it. As a result, adult illiteracy, which already affects over 900 million people, most of them in developing countries, is likely to remain a major problem.

3. Traditional means of education are not fully adequate to meet the needs of large populations for lifelong learning, even in rich countries. In developing countries, education for all, at least past the primary level, looks like an unrealistic dream if only conventional strategies are pursued. Even where available, the quality of education leaves much to be desired and is often declining as costs rise faster than incomes and tax revenues. The increasing cost of education in industrialized countries has consistently outpaced the rate of inflation. This reflects a lack of productivity growth in a crucial sector of what is increasingly becoming a knowledge-based economy.

4. Distance education programmes are a very promising development in meeting the educational needs of millions of children and adults, especially in developing countries where expertise and physical and financial resources are limited and the bulk of the population lives and works in rural or remote areas. The latest trends in education show that universities both in industrialized and developing countries have started programmes oriented to geographically dispersed students. Several institutions specializing in distance education have earned national and international pre-eminence.

5. The Open University of the United Kingdom has gained worldwide attention and many countries have developed their own open universities on this model. Founded in 1969, the Open University is now the largest university in the United Kingdom, with over 3,000 full-time staff and more than 200,000 students. Although television is used extensively, about 90 per cent of the instructional material is print-based. Face-to-face encounters with tutors in 13 regional centres supplement print and televised materials.

6. About 25-30 countries in the sub-Sahara region of Africa have distance teaching institutions, and a number of countries, including Kenya, Malawi, United Republic of Tanzania, Zambia and Zimbabwe, have been implementing distance education curriculums for several years. The University of South Africa (UNISA) is one of the largest distance-teaching institutions in the world. Formed in 1946, UNISA had more than 130,000 students register in 1995. Many countries have even established government institutions responsible for extending the scope and effectiveness of their distance education curriculums, such as the Institute for Distance Learning in South Africa and the Institute for Distance Education in Zimbabwe.

7. Delivery of instructional programmes via radio, which dates back more than six decades to the earliest national broadcasts offered by the British Broadcasting Corporation (BBC) in 1924, have become one of the most effective ways to bring distance education to a very wide audience, especially in developing countries. Supplemented by instructional materials on audio cassettes, educational radio broadcasts still play an important role in many developing countries in delivering programming to both schools and out-of-school learners. The Learning Technologies for Basic Education (LearnTech) project initiated by the non-profit Education Development Center, Inc., based in the United States, has been established to improve distance education in several African countries (Kenya, Lesotho, South Africa and Swaziland) through the use of Interactive Radio Instruction (IRI). Interactive radio is usually used as an aid to the classroom teacher in schools experiencing a lack of instructional materials and qualified staff.

8. Students who learn by IRI actively respond to a "radio teacher" several times each minute by answering questions orally, writing, reading, singing, manipulating simple materials or doing physical exercises. Working

with the Open Learning Systems Education Trust (OLSET), a South African non-governmental organization. LearnTech has brought basic education in English and mathematics to over 600 classrooms in South Africa with excellent results. In many cases, IRI has proven to be less expensive than text-based alternatives, but even more important, studies have indicated that students also learn better and have better attendance and lower drop-out rates.

9. Until recently, little was done in the developing world to bring the benefits of modern telecommunications capabilities to rural and remote areas and to utilize them for educational purposes. Terrestrial systems had to be built one step at a time, spreading out from major urban centres, and had to overcome great geographic barriers and high costs to reach remote areas. Telephone systems planners saw no way to justify the great expense of expanding to rural and remote areas where the number of potential users was too small to make such a service profitable.

10. The rapid development of satellite technology over the last three decades has changed this situation. Earth stations placed at remote sites can create nationwide communications networks without the need to build a complete chain of cable or microwave links covering the entire country. Technical advances have led to more powerful satellites, smaller Earth stations and a general reduction in the cost of all the elements of satellite-based systems. A global system of satellites now makes it possible to connect any place on Earth into international telecommunications networks. From an educational standpoint, these networks can be viewed as an all-encompassing, very effective delivery system that can be used to promote human resource development and information exchange.

11. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), held in 1982, considered the implications of satellite communications technology, in particular, direct broadcasting satellite technology, which was a primary means to deliver instructional television (ITV) programmes for educational purposes and the possibility of regional or international cooperation. UNISPACE 82 noted the requirements in developing countries to improve the educational infrastructure, not only to educate the young, but also to provide a continuing source of information, knowledge and know-how to the adult population. While the use of space technology does not provide instant solutions to these problems, it could complement conventional methods, accelerate the spread of education and improve its quality, particularly in remote and rural areas.

12. Developments in satellite-based telecommunications networks, information and digital technologies, as well as the convergence of telecommunications and computers, have been decreasing the cost of storing, processing and transmitting information by 50 per cent every 18 months. In addition to ITV programmes, these developments are providing educators with powerful tools to establish reliable, multi-site, two-way interaction with students in order to facilitate learning, maintain motivation and ensure steady progress via electronic distance education (EDE). This has led to a paradigm shift regarding education access, whereby education goes to the people rather than having people going to the schools or universities.

I. APPLICATIONS TO DISTANCE EDUCATION

A. Instructional television

13. ITV programmes have been used in many countries for a wide range of educational disciplines, with all types of audiences, for elementary, secondary and university education as well as for adult or continuing education in or outside conventional classrooms.

14. In the United States, experiments with ITV programmes were initiated as early as the beginning of the 1950s using both broadcast and closed-circuit television. Evaluation of these first experimental programmes showed that the technology was equally effective compared to conventional face-to-face means of instruction. An obvious advantage of ITV was that it could bring educational opportunities to students in rural and remote areas where qualified teachers in many disciplines were not available. In the 1970s, the experimental Application Technology Satellite ATS-6 was used to deliver ITV programmes to remote and rural areas in the Appalachian and Rocky Mountain regions and to the State of Alaska.

15. In the 1980s, the positive results of the ATS-6 experiment led a number of states, mostly those with large territories and low population densities, to establish state educational satellite networks. Many universities started distance education programmes using ITV as the primary means for programming delivery and designed to deliver both general educational programmes to rural schools and colleges and to offer accredited graduate and undergraduate degree courses to off-campus students. Now practically every large- or medium-sized university has distance education programmes based on ITV.

16. The Satellite Telecommunications Educational Programming (STEP) network was developed to provide equal learning opportunities for all students regardless of geographic location or educational resources. In 1990, STEP joined with state education agencies from Alaska, Idaho, Montana, Oregon and Washington to form the Pacific Northwest Star Schools partnership to provide distance education services to the five-state region. Using federal funds, STEP/Star partnership enhances and expands distance learning in a region connected by culture and economy. The programme offers ITV courses on a wide range of topics such as foreign languages, mathematics and science. Distance education is provided to approximately 500 schools in the five states serving some 6,000 students in the middle- and high-school grade levels. In addition to student services, the programme also provides professional development activities for teachers and school administrators.

17. The development of the technology also led to the establishment of educational institutions specializing entirely in distance education programmes delivered by ITV and through other new information technologies. The National Technological University (NTU) and the Mind Extension University (ME/U), also known as JEC Knowledge Online, rely heavily on satellite instructional television to distribute the courses of a group of participating conventional universities. NTU was founded in 1984 and it offers a wide range of advanced science and engineering courses using live, satellite-based narrowcast instructional television, sometimes backed by e-mail. About 45 technical universities in North America uplink to the NTU transponder using compressed digital television and there are downlinks in these same universities as well as some 500 sites in high-technology companies and governmental agencies. Both degree courses and continuing education seminars are offered. NTU seeks to be fully global by the year 2000.

18. ME/U employs a similar concept based on satellite and cable television, focusing mainly on technical and business courses, some of which permit interaction with the instructor and other students by telephone and/or e-mail. Of particular interest to educators is the Educational Technology Leadership master's degree programme established in 1988 at George Washington University using ME/U to meet a growing need among education professionals to understand, manage and use electronic educational technologies. The student body for this programme is international.

19. ITV has begun to penetrate the corporate environment as well. Besides large corporations such as IBM, Eastman Kodak and AT&T using their own internal satellite networks for employee training and new product presentations, many other smaller companies have installed their own receiving stations in order to receive programming from external specialized programme providers. A list of some North American ITV programme providers specializing in the development of ITV programmes for schools, universities, continuing and vocational education is given in appendix I.

20. The Public Broadcasting Service (PBS), within the framework of its Project VSAT pilot programme, is promoting the use of a single communications satellite dedicated to educational broadcasts as a carrier of ITV programmes, which are now delivered via a number of satellites, in order to develop better access by schools in the United States to existing ITV programmes. Implementation of this project would enable schools to receive a variety of ITV programmes using a single small receiving terminal, thus improving access, simplifying equipment and reducing costs. Project VSAT also promotes the use of advanced video-compression technology to increase the capacity of the satellite to allow it to transmit 20-40 programmes using five transponders. The increased satellite capacity will also provide schools with two-way communications capabilities allowing interaction with remote instructors.

21. In India, the Satellite Instructional Television Experiment (SITE), using the United States ATS-6 satellite stationed over the Indian Ocean, was carried out from 1975 to 1976. The satellite for this experiment was provided by NASA and the ground segment was designed and manufactured by the Indian Space Research Organization (ISRO) working in collaboration with All India Radio/Doordarshan. ITV programmes produced domestically were broadcast from Earth stations in Ahmedabad and Delhi via ATS-6. These programmes were received in 2,400 villages in several Indian states using specially designed three-metre parabolic antennas, front-end converters and television sets. In some cases the received programmes were rebroadcast by a VHF television transmitter to villages around the transmitter.

22. About 1,400 hours of programming were produced during the experimental period and included both the school ITV programmes and the evening programmes for adults, which combined general education and information with entertainment. Special training programmes in mathematics and science for school teachers were also shown to approximately 50,000 educators in rural and remote areas.

23. Receiving equipment was made in India and its design met climate conditions in the country. Ground stations were placed mostly in electrified villages, but 180 non-electrified villages were selected for battery-powered sets. To address the problem of maintenance and repair, which is as critical as it is common in rural areas in developing countries, a network of field service stations was established. Each field station serviced up to 100 television receiving sets in as many villages, and any equipment problems were reported by mailing a prepaid questionnaire-format postcard to the nearest service station.

24. The development of an operational domestic Indian satellite communications system on the basis of INSAT satellites allowed television coverage to be extended to most of the country through direct reception systems or through a network of community receivers and rebroadcasting stations. The Ministry of Education has established a Central Institute of Educational Technology (CIET) and six State Institutes of Educational Technology (SIETs) to run satellite-based ITV programmes. Currently, this service regularly provides 45 minutes of educational programmes for children of different age groups and for teachers in each of the five regional languages. In order to fully utilize the capabilities of satellite-based ITV, ISRO is developing a new concept of a dedicated GRAMSAT satellite mission to deliver ITV programmes as well as cultural and health information to both rural and urban areas all over the country in each of the regional languages.

25. In Brazil, which also used the ATS-6 satellite for educational broadcasting in the 1970s, the Roberto Marinho Foundation (FRM) has taken the lead in ITV. The FRM has about 15 years of experience in various telecourses and other distance education programmes. FRM is the non-profit subsidiary of the Brazilian Globo Television network, the fourth largest private television network in the world.

26. The latest educational initiative of FRM is the ITV *Telecurso 2000* project initiated at the beginning of 1995. It is providing primary, secondary and vocational ITV-based education targeted to the approximately 50 million people who dropped out of or never entered the formal educational system of Brazil. One of the key elements of the project is the extensive use of so-called telesalas–special training rooms with television monitors

and teaching assistance available at community centres, churches, large factories and prisons. It is broadcast by the Globo Television network before the popular "Good Morning, Brazil" programme, rebroadcast during the day on educational networks and supported by print materials available at news-stands throughout the country. Accreditation through a certified examination has been negotiated with state governments.

27. What is unique about this project is that it is financed by the private sector–FRM itself and the Federation of Industries of São Paulo (FIESP)–and is supported by the National Industrial Training Service (SENAI). While the project is still relatively new, the number of participants is growing rapidly and now includes *telesalas* in hundreds of industrial enterprises, industrial training centres, community centres and federal penitentiaries. At the end of March 1996, organized *telesalas* with teaching assistants trained by FRM totalled 1,517 with about 41,000 students. An additional 575 *telesalas* with 15,000 students have been scheduled to start operating with support from the Bradesco Foundation. The number of students studying at home or in informal groups is expected to be much higher.

28. In the Brazilian State of Minas Gerais, the State Secretariat of Education is considering the use of satellite communications systems to deliver ITV programmes developed in support of the Basic Education Quality Improvement Project (ProQualidade). ITV programmes will focus on the training of about 90,000 primary school teachers in Minas Gerais, where 5,500 schools have already been equipped with television sets, video cassette recorders and satellite television receiving antennas under a Brazilian federal government programme.

29. In China, the Central Radio and Television University (CRTVU), an institution that operates directly under the authority of the State Education Commission, runs multimedia distance higher education courses using radio, instructional television, print-based and audiovisual teaching materials. It was inaugurated in February 1979 and now heads a modern distance education system made up of CRTVU, 43 provincial, autonomous regional and municipal television universities, 654 branch schools at the prefecture and city level, 1,500 work stations at the county level and more than 10,000 teaching classes that cover rural and urban areas of China. While initially using the microwave network of China Central Television the entire Chinese distance education system centred on CRTVU now uses Chinese communications satellites capable of reaching all of China plus neighbouring countries in eastern, central and south-east Asia. With 146,000 entering students, 300,000 students matriculated and 120,000 graduates in 1992, CRTVU is probably the world's largest university.

30. Prior to the establishment of an operational domestic satellite communications network capable of nationwide delivery of ITV programmes, China carried out a distance education pilot project in 1985 using a satellite transponder provided free of charge by INTELSAT within the framework of its Satellites for Health and Rural Education (SHARE) programme. As a result, 53 small Earth stations were installed in remote and rural areas of China to receive ITV programmes and for rebroadcast for local reception. Transmitted ITV programmes included advanced academic courses in various disciplines broadcast six hours each day, as well as more diverse educational materials such as lectures on calligraphy, oriental fine arts and health care.

31. The pilot project proved to be very successful in terms of both educational achievements and cost-efficiency, and the Government of China decided to develop a full-scale nationwide ITV network using domestic communications satellite capacity and two satellite transponders leased from INTELSAT. By 1987, the national television network, which included ITV as an integral part of its programming, had become operational. The State Education Commission led the educational effort and established the China Educational Television (CETV) to produce and broadcast ITV programmes via satellite. Working in cooperation with the Ministry of Posts and Telecommunications, CETV operates the Earth station to broadcast daily via INTELSAT and Chinasat 31 hours of ITV programming on two channels devoted to educational television. Educational organizations in provinces can produce and broadcast their own ITV programmes through these channels as well.

32. By the end of 1990, about 36,000 hours of ITV programmes had been delivered over two educational channels. More than 600 receiving and rebroadcasting stations and 4,000 direct receiving systems had been installed in 29 provinces. In addition to academic or general education programmes, CETV offers distance training for elementary and secondary school teachers in rural and remote areas as well as programmes in continuing, professional and adult education. About 20 million people view CETV programmes or take ITV courses either at home or at learning centres throughout the country.

33. In Australia, a number of states use satellite ITV on an operational basis to deliver educational programmes to primary and secondary schools located in rural and remote areas. By the end of 1994, 170 rural schools in the State of Victoria were equipped with small receiving terminals, at an average cost of $1,700 per site. The equipment provides two-way, interactive communications between the classroom and the remote central studio. During the telesessions, students have the opportunity to communicate with the lecturer/presenter in the central studio while watching the programme and can ask questions and have them answered immediately, allowing them to be actively involved in the learning process. Using this system also enables students to become familiar with modern technology from an early age.

34. The lessons are delivered from the studio of the Victorian Directorate of School Education. From there the programmes are sent via the Telecom network to an Optus uplink facility for transmission to the satellite. Classroom teachers work in partnership with the television presenters to ensure that students get the most out of the programmes. Print and audio materials are supplied to participating schools for use between broadcasts. Funding for this effort has been provided by the Victorian Education Foundation, Country Education Project, the Directorate of School Education and individual sponsors. The success of these ITV programmes led to the decision by the Minister for Education to provide all government schools in Victoria with free satellite receiving equipment.

35. The Education Department of the State of Western Australia uses the government-sponsored Westlink service to deliver state-wide ITV programmes produced by the Education Interactive Television Centre at Leederville. The Westlink service allows the distribution of teaching and learning programmes at a fraction of the normal commercial cost associated with satellite transmission. Programmes are transmitted for four hours each week using a satellite system that provides for a one-way broadband video system with an audio return path. In 1994, 130 hours of ITV programming were delivered to rural schools in Western Australia.

36. Indonesia was the first developing country to operate its own satellite communications system in 1976 when it launched Palapa A-1 and made it possible to provide all 26 provinces of this archipelago nation with improved telephone, telex, radio and television services. The network of Earth stations has expanded from 40 ground stations installed at the beginning to more than 200 after two decades of operation.

37. In order to explore the most effective ways of using the Palapa system for specific development programmes, Indonesia started the Indonesian Distance Education Satellite System (SISDIKSAT) project in 1981 in close cooperation with the United States Agency for International Development (USAID) and as a part of the USAID-sponsored Rural Satellite Program (RSP). Linking 15 distant universities in the eastern part of Indonesia, an open interactive audioconferencing network was established on the basis of the Palapa satellite communications system to deliver academic courses to university students, upgrade faculty skills through in-service training programmes and facilitate administrative and institutional communication. It also made available the expert resources of each institution to all members of the network, thus multiplying each professional's outreach and effectiveness. A variety of educational programmes was delivered to all members of the network, including 60 academic courses and over 30 seminars. More than 10,000 students benefited from these interactive programmes and other services offered by SISDIKSAT.

38. In Europe, the Education Across Europe project sponsored by Matra Marconi Space connects 12 schools and colleges in the United Kingdom with a number of participating schools in Austria, France and Slovenia. ITV programmes, covering such subjects as geography, history and languages, are transmitted via Eutelsat satellite. The project began in 1992 and is ongoing and developing.

39. INTELSAT, which owns and operates the world's most extensive global communications satellite system, contributed much to the development of satellite telecommunications applications to distance education, especially through its project SHARE. Project SHARE, initiated jointly by INTELSAT and the International Institute of Communications (IIC) in 1984, provided free use of the INTELSAT international satellite network to foster telecommunications development in rural and remote areas, with the primary aim of assisting in distance education and health care.

40. Originally, the project had been intended for only a 16-month period, but it proved to be such a success that it was extended twice and was operational until the end of 1987. The national ITV network in China, mentioned above, is one example of the types of project undertaken within the SHARE framework.

41. As a follow-up to project SHARE, the Project Access programme was established by INTELSAT to provide free satellite capacity, for a limited duration, for education and health care. One of the latest activities under the Project Access mandate is the establishment of a pilot "Distance Education and Training Network of the Americas", which will take place in early 1997. The pilot network to be designed by INTELSAT with the assistance of the National Education Telecommunications Organization/Education Satellite NETO/EDSAT, will benefit students in rural and remote areas of the United States and other countries in the Americas, as well as serve as a model for establishing similar networks in developing and industrialized countries and lead to the development of a full-time, self-sustaining global distance education network.

42. Experimental and operational programmes and projects in distance education carried out by many countries have shown that satellite communications technology is well developed and can be successfully applied to distance education by both developing and industrialized countries. Numerous evaluation studies have demonstrated that ITV is capable of delivering information and developing skills in many disciplines with effectiveness comparable to, and in some cases exceeding, conventional education systems.*

43. While technology itself and the equipment associated with this technology currently do not pose any significant problem to ITV projects, the overall organization of a project and ITV programming are among the main difficulties experienced by countries and organizations, including the underestimated importance of organizational issues such as coordination between telecommunication and education authorities, training teachers in distance education methodology, publication and distribution of printed materials that support ITV programmes, synchronization of broadcasts with school curriculums and setting up a network of community centres for viewing programmes. These problems can substantially reduce the effectiveness of any programme.

44. The production of educational programming is also an extremely important, and often a very expensive, element of any ITV project. Programmes should be designed in a fashion that reaches a target group in the most efficient and cost-effective way and taking into account the national and age peculiarity of the students. Use of graphics, special visual effects and on-site recording can enhance educational content and, at the same time, make a programme more attractive for the audience. Organization of interactive telesessions, which make

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*A comprehensive overview of research reports, studies and articles published from 1945 to 1995 on the effectiveness of distance education in general, and ITV in particular, can be found in the paper "The 'No Significant Difference' phenomenon", by Thomas L. Russell, Director, Office of Instructional Telecommunications, North Carolina State University, which is available on the Internet at URL http://tenb.mta.ca/phenom.

possible live communication between student and remote lecturer, not only increases the effectiveness of ITV programmes but also provides a programme provider with necessary feedback.

B. Electronic Distance Education

45. In recent years, the rapid development of new information technologies, especially telematics (the intersection of informatics and telecommunications), has affected virtually every sector of economic, social and political development. The technological changes have led to decreased costs in hardware and software for storing, processing and transmitting information, increasing miniaturization, portability and diversity of information-processing and communication equipment, and the capability to present and manipulate information in all media–data, text, voice, image and video–in ways that increasingly match individual preferences and cognitive styles.

46. The convergence of telecommunications, computers, satellites and fibre optics technologies is critical to the knowledge-based economy of the future. This convergence also promises to make the knowledge base of humanity available anywhere, any time, in any language, at cost-effective prices and in an interactive format. Because of the global, borderless nature of electronic networks and their fast delivery of information, networked education can enhance the whole spectrum of the educational experience, including the effective use of educational resources worldwide, improved student-teacher interaction, the opportunity for students to contribute to the development of course materials and information sharing between educators and researchers.

47. The Internet is the largest, most powerful and fastest-growing computer network in the world. It is estimated that more than 40 million people have access to the Internet and that in mid-1995 there were around 5 million host computers worldwide connected to the Internet. Over 110 countries have direct Internet access with at least one host computer in the country; if other e-mail networks are taken into account, about 160 countries have links to the Internet.

48. The Internet has been used increasingly in the last few years to deliver educational material and distance education programmes in both industrialized and developing countries. Internet-based learning allows students to learn at their own pace and access the information at a convenient time, and provides education to remote students who otherwise would not be able to travel to a classroom.

49. Some courses available on the Internet are delivered as a formal programme complementing regular meetings between students and teachers in the classroom. A large number of institutions offer on-line courses through the Internet in a wide range of disciplines and topics that can lead to diplomas or formal accredited degrees.

50. Other Internet sites offer informal education at no charge on topics ranging from an interactive medical tutorial on the spinal cord and text books on chemistry, mathematics and physics, to learning languages such as Japanese, German and English, and include an educational site on archaeology.

51. Students participating in EDE programmes receive texts and workbooks via either regular mail or the Internet. Through common files assigned to a class that each student can access, teachers upload syllabuses, lectures, grades and remarks. Remote students download these files, compose their assignment and remarks off-line, then upload them back to the common files. Students and instructors are usually required to log in for a certain number of days during a week. Through these networks, faculty, students and the administration of the institution have easy access to each other as well as access to database resources provided by libraries. Some examples of formal education programmes offered through the Internet are given below:

(a) CyberEd Dartmouth is a World-Wide-Web-based system that offers full-credit university programmes from the University of Massachusetts, Dartmouth Division of Continuing Education. While traditional resources such as textbooks are used, students also draw on the extensive resources already available on the Internet. Class material and assignments are posted on the World Wide Web at a site open only to those students taking the course;

(b) International University College (IUC) offers a Master of Arts in Business Communication. The primary way students communicate with the teaching faculty, administrative staff and other students is through e-mail. IUC uses mailing list managers (listservs) to enable course discussions and these listserv discussions are an important portion of the course grade. Students submit written assignments to teaching faculty through e-mail and assignments are returned with comments and suggestions in the same fashion. Listservs allow students to discuss group projects with other members of the class and to send questions or comments to teaching faculty or classmates;

(c) The University of Paisley Online Education WWW Server provides degree courses from accredited universities aimed at working professionals. The courses can lead to degrees such as a Bachelor of Science in Health Studies, a Master of Business Administration (MBA) in Marketing, a Master of Science in Computer Aided Engineering and an MBA in Total Quality Management. Each enrolled student is provided with an advanced PC, a high-speed modem and a printer, which are delivered and set up in the student's home. Students interact with tutors by connecting to the Electronic Campus on Internet. Frequently travelling students can use notebook computers that allow them to continue studying anywhere. Course materials are pre-loaded in the computer supplied and consist of notes in hypertext, together with a software package for word-processing, graphics, analysis and communication. Students engage in live teleconferencing, closed and open discussion forums and e-mail, through which students send their assignments to their instructors for evaluation. An on-line library on the Internet is also available;

(d) The City University of Bellevue, Washington, Education Resource and Online Academic Degree System (EDROADS) offers more than 80 programmes at the undergraduate and graduate levels that cover a variety of academic fields such as business management and technology, humanities, the social and natural sciences and counselling. Master of Business Administration and Master of Education degree programmes are also offered.

A list of selected programmes and courses available on-line is given in appendix II.

52. A variety of technologies are currently being used to deliver education programmes over the Internet including the World Wide Web for on-line lecture notes, newsgroups for collaborative discussions and class announcements, video and audio instructions, e-mail correspondence between students and instructors, interactive desktop videoconferencing and computer-conferencing for remote participation in classes and group discussions and virtual reality for exploring three-dimensional scenes. Multimedia is increasingly being used in on-line education to enhance the learning process.

53. One of the most prominent trends in distance education brought by informatics is the emergence of the open learning concept, which can be defined as "a student-centred approach to education which removes all barriers to access to information while providing a high degree of learner autonomy". The Internet supports the open learning concept by providing students with the ability to connect to educational resources when it is convenient for them and allowing students to explore the educational resources in a fashion that suits their needs. In an open learning environment the teacher no longer serves as the keeper of knowledge. Instead, the teacher acts as a tutor, facilitator and resource to assist in the student's learning process.

54. A large number of projects in the development of national and international distance learning infrastructures have been carried out in various countries. Since 1993, Canada has been working on design and implementation of a national Internet-based educational network called Canada's SchoolNet. Japan is developing the Asia-Pacific Interactive Communication Network (APICNET) for international cooperation, international cultural exchange and education aimed at creating a global classroom on the Internet. APICNET has made it possible for schools in Japan to participate in projects planned by educators in other countries as well as to devise their own projects and invite participation from schools overseas.

55. Since 1993, the Ministry of Education in Chile has been developing an educational network that connects more than 100 elementary schools in rural and remote areas in order to provide students and teachers with educational support as well as with access to information resources available on the Internet. In Australia, the Queensland Open Learning Network (QOLN) was initiated by the State government in 1990 in order to establish a state-wide delivery system for education and training using interactive communications technologies. The network comprises over 40 open learning centres spread throughout the State to provide remote learners with access to computer teleconferencing and audioconferencing, e-mail and satellite ITV reception facilities.

56. The European Schools Project (ESP) was initiated in 1988 by the University of Amsterdam to explore educational applications of telematics. ESP has spread out to 26 countries, offers participating schools educational, organizational and technical support, and provides opportunities for electronic communication between students, teachers and educational networks for the design and implementation of cooperative EDE projects and for the development and effective use of information resources to enhance learning and teaching. In Ghana, a SchoolNet project was initiated at the beginning of 1996 with the immediate goal of connecting 50 secondary schools and providing them with access to the Internet. The project will open new opportunities for students to interact, both locally and internationally, with teachers and other students as well as enable them to participate in the open learning programmes over the Internet.

57. In the United States, the National School Network Testbed (NSNT) project was organized by the National Science Foundation (NSF) in 1992 in order to explore ways in which schools and other educational institutions could take advantage of Internet-based learning and build their own local information infrastructures in support of desired educational reforms. Currently, about 250 institutions participate in the project, including 150 schools across the United States, one school in Canada and one in Australia. The Common Knowledge: Pittsburgh network project was initiated in 1992 to provide participating schools with access to educational and information resources not available to the Pittsburgh school system. The project enhanced the teaching environment and served the development of curricular activities in all subject areas and at all grade levels; for example, a virtual classroom for German language instruction was established on-line.

58. These and many other projects have shown that network-based delivery of education programmes provide many benefits to both the remote student and the educational institution. But owing to the relatively short period of time that on-line EDE programmes have been used, a complete evaluation of the role networked distance education plays in the formal education system as well as the effectiveness of the EDE methodologies is very difficult. However, the growing number of institutions offering networked EDE programmes and the widening range of educational disciplines and topics available on-line reflect the fact that networked distance education has already become an integral part of the current educational environment. This trend is supported by the declining cost and increasing capacity of the required hardware and software as well as by the declining cost of communications.

59. Until recently, the participation of developing countries in global computer networking was extremely limited because of the undeveloped basic communication infrastructures, especially in rural and remote areas. There are more telephone lines in Manhattan, New York, than in all of sub-Saharan Africa, as noted by Thabo Mbeki, Deputy President of South Africa. In 1992, 49 countries had fewer than one telephone per 100

people. Outdated terrestrial communications networks and a lack of international interconnectivity in many developing countries create a situation where a telephone call from Senegal to Zambia is routed through London. In addition, these networks simply cannot support a data transfer speed of 9.6 kilobits per second over a distance of even a few kilometres.

60. In the last few years, developing countries have spent a great deal of effort to overcome their existing communications problems and to join global electronic networks in order to enhance national educational and scientific capabilities. Satellite communications systems have been used by many countries to develop cost-effective networking solutions. A number of projects carried out by different organizations proved that access to e-mail arranged through communications satellites could provide a low-cost and reliable means of delivery of educational programmes to remote and rural areas in developing countries.

61. For example, HealthNet is a computer-based telecommunications system that links health care and health education workers around the world. Since 1994, HealthNet has provided its users (more than 4,000 in more than 30 countries worldwide) with low-cost e-mail connectivity through a Low Earth Orbit (LEO) HealthSat store-and-forward microsatellite and radio links from any area with little or no telecommunications infrastructure. Inexpensive ground equipment needed to contact the satellite consists of an IBM-compatible PC, a Terminal Node Controller (TNC), a satellite radio and antennas. HealthSat is capable of storing and forwarding full-duplex communication at 9,600 bits per second.

62. The Volunteers in Technical Assistance (VITA) organization is assisting the Global Learning and Observations to Benefit the Environment (GLOBE) Programme to reach into developing countries by providing capacity from its VITASat LEO communications satellite system. This system comprises a store-and-forward communications satellite which allows e-mail and data to be delivered anywhere in the world in 90 minutes and a network of low-cost highly portable ground stations designed specifically for developing countries.

63. The GLOBE Programme was introduced in 1994 as a part of the Global Information Infrastructure (GII) initiative and began operations in early 1995. More than 2,500 schools in 43 countries participate in this international science and education programme aimed at gathering and sharing information to better understand the global environment as well as helping all participating students reach higher standards in science and mathematics. Guided by trained teachers, students in participating schools conduct a wide array of core and elective observations, ranging from basic weather parameters such as temperature, atmospheric pressure and precipitation to more sophisticated measurements such as water chemistry, biodiversity and patterns of seasonal change. These measurements are sent by various means, including global computer networks and communications satellites, to processing centres where they are combined with information gathered by other GLOBE students, scientists and Earth observation satellites. The students receive next-day feedback from the scientific community on how their data is being used.

64. Following the worldwide trend of establishing National Information Infrastructures (NII) and their integration into GII, virtually all developing countries have started working on the development of high-performance computer networks that link national universities, schools, libraries and research centres and are capable of facilitating high-speed Internet data access and retrieval. In many cases these projects are carried out as regional or international efforts.

65. Current satellite communications technology provides a cost-effective and flexible option for establishing access to the Internet (including a full range of services such as e-mail, file-sharing, file transfer and computer-conferencing) as well as for interconnection of remote sites in developing countries through a network of standard ground stations or through Very Small Aperture Terminals (VSATs), which provide a more advanced solution. A number of projects carried out by the developing countries aim at establishing educational computer networks using a combination of satellites, terrestrial lines and microwave links.

66. In 1991, the Organization of American States initiated the Hemisphere-Wide Inter-University Scientific and Technological Information Network (with the Spanish acronym of RedHUCyT) project with the main objective of connecting member States to the Internet by integrating an electronic network to exchange information and programmes among different academic and scientific institutions.

67. In the Caribbean region, an electronic information network linking the universities of the Caribbean, known as the Caribbean Academic, Scientific and Technological Network (CUNet), was formally launched in September 1991. More than 20 nodes in the subregion currently connect, via dial-up, over 1,000 users within the CUNet framework. RedHUCyT has supported the establishment of the Jamaican Electronic Network (JAMNet), allowing Jamaica to be fully connected to the Internet. With a 64-kilobits-per-second satellite link to the United States National Science Foundation Network (NSFNet), 400 hosts at the University of the West Indies have received full connectivity to the Internet.

68. In Central America, resources have been allocated for establishing a backbone of interconnected institutions, with Costa Rica serving as a hub and other countries connected via direct satellite links. The National Research Network of Costa Rica (CRNet) has been connected to the Internet through a satellite link to a NSFNet server in Florida. RedHUCyT provided equipment and technical assistance for setting up the Nicaraguan Academic Network and connecting it to Costa Rica through microwave links. The connection of Panama to the Internet, also through CRNet, linked these three major universities in 1994. RedHUCyT has also provided equipment, technical assistance and training to Argentina, Bolivia, Chile, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela, and satellite Earth stations have been installed in Mexico, Peru and Venezuela.

69. The Pan-Pacific Education and Communication Experiments by Satellite (PEACESAT) programme has a primary mission to support international distance education, research, telemedicine, emergency management and economic development experiments and applications, as well as to provide an opportunity for research in the development and applications of low-cost satellite communications technologies. PEACESAT achieves these mission goals through the use of satellite communications and provides many different non-commercial services. These services include access to the Internet and other information services, point-to-point and voice conferencing and compressed video.

70. The PEACESAT network ties together government, educational and other non-profit national and regional organizations in 22 Pacific countries. There are 44 PEACESAT Earth stations in this network with nine more in the planning stages. Through this network, PEACESAT helps to integrate participating countries into GII.

71. PEACESAT is funded in part by the National Telecommunications and Information Administration of the United States Department of Commerce. The programme began in 1971 through the use of a single voice circuit on ATS-1, and it now operates nine simplex and three full-duplex circuits on the Geostationary Operational Environmental Satellites of the National Ocean and Atmospheric Administration. In addition to Internet services, PEACESAT has also developed and implemented remote access capability and electronic post-office systems, and is exploring the deployment of special interfaces to its Earth stations to support low-cost continuous access to the Internet for extremely remote areas and for management of emergency cases.

72. In South Africa, the Telematics for African Development Consortium has been established in order to promote distance education programmes in the region. The consortium consists of such companies and institutions as the South African Broadcasting Corporation, the Telcom S.A. telecommunications company, the research centre known as CSIR, the University of South Africa (UNISA), which is a specialized distance education institution, the University of Pretoria, St. Alban's College and some other community organizations and private enterprises.

73. The initial projects of the Consortium are the first phase of a multiphased programme expected to last at least five years and to reach out to other African countries. Through a number of pilot projects, the first phase is intended to prove concepts and to test the efficiency of satellite communications and other wireless technologies for networking and connecting to the Internet through VSATs and specially developed infrared/laser interfaces. The objectives of the first phase are to provide the following:

(a) *A prototype Internet-based academic English reading skills course for 7,600 students at UNISA*. This programme is aimed at helping raise the scores of students who could not meet the minimum education entrance requirements to institutions of higher education. Once tested and evaluated, the course will be made available to all UNISA students (currently numbering some 128,000) and, as a free public service, to anyone with Internet access through the UNISA server;

(b) *A prototype Internet-based biology syllabus and course for use by secondary level school students and teachers*. Once tested and evaluated, the programme will be made available to teachers and students with Internet access;

(c) *Wireless wide-area high-bandwidth connectivity for the disadvantaged township of Mamelodi and for the rural school outside Pretoria*. After testing, this concept will be developed into a system that can be replicated throughout Africa to provide wireless access to networks in remote and rural areas where there are no existing telecommunications infrastructures;

(d) *Informal information services through the wireless infrastructure to the disadvantaged community of Mamelodi*. This project provides the means to acquire training in basic life skills, transparent governance and small business development;

(e) *Examples of development tools which will facilitate and accelerate further development of the project*. These include the development of a curriculum creation and management tool and a multimedia interface supporting effective delivery of the educational content to students.

74. The Consortium is actively seeking cooperation with other organizations and institutions interested in contributing to the solution of African telematics problems. The Telecommunications Foundation for Africa, based in Kenya, is involved in the activities of the Consortium and negotiations are under way with the Informatics Centre of Eduardo Mondlane University at Maputo, Mozambique.

75. The Office for Outer Space Affairs (OOSA), within the framework of the United Nations Programme on Space Applications, is working in cooperation with the European Space Agency (ESA) on a project proposal aimed at establishing a cooperative information network linking scientists, educators, professionals and decision makers in Africa (COPINE). This project is the response of OOSA to a recommendation of the United Nations regional conference held at Dakar in 1993 on the need to establish efficient communication links between African scientists and professionals. When operational, COPINE would be a satellite-based information exchange network with interactive capability linking urban and rural centres in 13 African countries (Botswana, Eritrea, Ghana, Malawi, Mozambique, Namibia, Nigeria, South Africa, Tunisia, Uganda, United Republic of Tanzania and Zimbabwe) and selected hospitals, universities and information centres located in Europe.

76. The wideband capabilities of COPINE will be used to provide a variety of information delivery services, particularly computer file transfer, interactive data exchange and audio, image and video transmission, in order to facilitate projects in health care, distance education, scientific and technical information exchange and natural resource and environment management. The objective of the distance education applications of the COPINE system would be to improve the quality of education in remote and rural areas by providing educators in these areas with a tool that gives them easy and efficient access to the education centres of their countries. Through

its e-mail connection, COPINE also would offer educators in rural areas electronic access to information databases around the world.

II. CONCLUSIONS

77. Within the global context of rapid technological changes and shifting market conditions, conventional education systems worldwide are challenged, without increased budgets, with providing increased educational opportunities required by a knowledge-based economy. Many countries and national and international educational institutions are answering this challenge by developing distance education programmes. The number of these programmes has grown very rapidly in order to meet the increasing demand for flexible lifelong learning available for all. According to the International Centre for Distance Learning (ICDL) of the Open University of the United Kingdom, there are currently about 30,000 distance courses and programmes offered by institutions in the countries of the Commonwealth and about 850 distance teaching institutions worldwide.*

78. The development of telecommunications systems and new information technologies has made distance education, and in particular interactive ITV and EDE, as effective as traditional instruction, if the methods and technologies used are appropriate to the instructional tasks. The open learning approach, which has been introduced through new information technologies, allows students to work at their own pace and provides them with greater control over the learning process.

79. From a technical point of view, satellite communications systems provide educators with reliable and powerful means for delivery of ITV and EDE programmes, and give learners, especially in remote and rural areas, opportunities to access desired education programmes, which otherwise are not available locally. The technologies are in place and their feasibility has been demonstrated in numerous projects carried out on a national or international scale. Further convergence of computing, telecommunications and television will make it possible to provide all three services over a single network in the near future.

80. However, ITV and EDE programmes should not be viewed as a complete replacement of teachers and conventional educational processes, but rather as important components of improving and enhancing instruction and learning processes. Educational technologies change the role of the instructor, and pro-active steps should be taken to mediate these changes. Efficient organization of projects and the development of appropriate educational content are very important for effective implementation of ITV and EDE programmes. Programming should include interactive elements and should also be designed to meet both the needs of the learners and the requirements of society. Timely feedback from instructors and regular evaluations of the progress of students should be an integral part of the distance education process.

81. The applications of satellite communications to distance education currently are in transition from experimental to operational use, particularly in developing countries. The projects discussed in the present study illustrate the value of space communications systems for the promotion of distance education programmes in various countries, but do not by any means exhaust the ways in which space technology can be used for such programmes. Rather, the examples are intended to reflect ways in which countries and institutions using space communications can develop new approaches to meet the educational needs of society.

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*ICDL has established a database of distance education resources. This database contains detailed entries on available distance education programmes and on institutions offering these programmes, as well as reference to approximately 8,000 books, journal articles, conference papers, research reports and other types of literature related to all aspects of the theory and practice of distance education. This database can be accessed through its Internet home page at http://www-icdl.open.ac.uk/icdl.

82. Updated information on the ongoing distance education projects as well as the latest developments in applications of new technologies, including space communications, to distance education can be found in numerous journals and periodicals, some of which are listed in appendix III.

Appendix I

SELECTED NORTH AMERICAN SATELLITE INSTRUCTIONAL TELEVISION PROGRAMME PROVIDERS*

American Chemical Society (ACS) satellite television seminars. The ACS satellite television seminars offer the opportunity to learn directly from and speak with leading experts in a variety of chemically related fields. The broadcasts can be downlinked throughout North America; access to overseas sites can also be arranged.

American Law Network (ALN). ALN transmits high-quality continuing legal education programmes and related events via satellite to viewing sites throughout the United States.

American Management Association (AMA). AMA broadcasts via satellite live interactive management and professional video conferences directly to receiving stations at user sites.

CSUSAT-CHICO. ITV programme consisting of live courses that originate from California State University, Chico campus, and are broadcast via satellite throughout California to selected sites.

Community College Satellite Network (CCSN). A division of the American Association of Community Colleges, CCSN is a coalition of higher-education institutions sharing resources through the cooperative use of satellite technology to serve the needs of its members, their communities and business and industry.

Federal Training Network. The Federal Training Network provides satellite-based training for government and private organizations nationwide.

Mass LearnPike. This interactive educational television network offers programmes designed to supplement the K-12 curriculum and to provide teacher professional development. The programmes can be viewed live via satellite and/or taped for later use.

NASA Aerospace Education Services Program. The NASA Aerospace Education Services Program is a nationwide, free programme for teachers, students and the general public.

National Technological University (NTU). NTU is a private, accredited, non-profit institution founded in 1984 to meet the advanced educational needs of engineers, scientist and technical managers through satellite delivery of advanced technical education.

National University Teleconference Network (NUTN). NUTN supports applications of new and emerging technologies in videoconferencing and distance education.

PBS Adult Learning Satellite Services (ALSS). PBS established ALSS to deliver, via satellite, a broad range of high-quality educational programming directly to colleges, universities, businesses and other organizations.

Satellite Educational Resources Consortium (SERC). With SERC programmes, students can join thousands of others around the United States to participate in courses outside their regular school curriculum.

Satellite Communications for Learning (SCOLA). SCOLA is a non-profit educational consortium that receives and retransmits ITV programming from more than 30 different countries in their original languages. These

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*Data source: University of Wisconsin World Wide Web site (http://www.uwex.edu/disted).

programmes are transmitted via satellite to schools, colleges, universities, government and military installations, businesses and private individuals throughout North America and much of the north-western hemisphere. SCOLA operates two 24-hour satellite channels with more in the planning stages.

Appendix II

SELECTED PROGRAMMES AND COURSES AVAILABLE ON-LINE*

Athabasca University. Canadian open university specializing in distance education.

Cornell University. Programme in instructional and informational applications of microcomputers.

Christopher Newport University. On-line full-credit college courses.

European Association of Distance Teaching Universities/Open University of the Netherlands. The seventeen national members of the Association collectively provide distance education programmes.

University of Geneva. Provides information on designing courses for the World Wide Web.

University of Indiana, School of Education, Distance Education Programme. Offers beginning and experienced educators fully accredited coursework that can be completed at home at a pace that suits their schedules.

Internet University. On-line college-level credit courses.

Mercy College. Offers a number of undergraduate credit courses on-line.

University of Minnesota, Department of Food Science and Nutrition. Offers a number of courses via the Internet.

National Teachers Enhancement Network. Offers graduate-credit science and mathematics courses to teachers nationally.

University of Phoenix. Offers accredited graduate and undergraduate degrees in business administration and management entirely on-line.

Rochester Institute of Technology. Offers interactive distance learning programmes in electrical/mechanical/telecommunications software and software development and management.

SPECTRUM University. More than 10 free courses are offered over the Internet.

The Virtual Global College. Provides lifelong learning via the Internet free of charge to promote learning in developing countries.

Washington State University. Offers digital image processing course.

World Lecture Hall. Contains links to pages created by faculty worldwide who are using the World Wide Web to deliver class materials such as course syllabuses, assignments, lecture notes, examinations, class schedules and multimedia textbooks.

Fayetteville Technical Community College (FTCC) Virtual Campus. Offers a selection of standard, full-credit college courses to the global audience of the World Wide Web.

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*Data Source: TeleEducation New Brunswick, Canada.

Appendix III

SELECTED JOURNALS AND PERIODICALS COVERING DISTANCE EDUCATION*

American Journal of Distance Education. Three issues per year; published by the American Centre for the Study of Distance Education, College of Education, Pennsylvania State University, 403 South Allen Street, Suite 206, University Park, Pennsylvania 16801-5202, United States of America.

Distance Education. Published each May and October by the Distance Education Centre, University of Southern Queensland, Post Office Darling Heights, Toowoomba, Queensland 4350, Australia.

Epistolodidaktika: the European Journal of Distance Education. Two issues per year; journal of the Association of European Correspondence Schools; subscription enquiries to The Rapid Results College, Tuition House, London, SW19 4DS, United Kingdom.

Indian Journal of Open Learning. Published each January and July by the Indira Gandhi National Open University, Maidan Garhi, New Delhi 110 068, India.

Istruzione a Distanza (IAD). Published quarterly by Istruzione a Distanza, Piazza San Carlo III, 42 I-80137 Napoli, Italy. The language of the journal is Italian, but coverage is international.

Journal of Distance Education. Published each November and May by the Canadian Association for Distance Education (CADE), 205-1 Stewart Street, Ottawa, Ontario, Canada, K1N 6H7.

Open Forum: Distance Education and Open Learning. Published by the Distance Education Centre, University of Southern Queensland, Post Office Darling Heights, Toowoomba, Queensland 4350, Australia.

Open Learning. Published each February, June and November by the Longman Group Ltd, Fourth Avenue, Harlow, Essex, CM19 6AA, United Kingdom.

Open Learning Update. Published each February, May, August and November by the Open Learning Technology Corporation Ltd, Science Park, Laffer Drive, Bedford Park, South Australia 5042, Australia.

Open Praxis. Two issues per year, in April/May and September/October, by the International Council for Distance Education (ICDE), Gjerdrums vei 12, N-0486 Oslo 4, Norway, as successor to the *ICDE Bulletin*.

Revista de Educación a Distancia. Published three times each year by RED, Centro para la Innovación y Desarollo de la Educación a Distancia, Argumosa No. 43, Pabellón 6, 28012 Madrid, Spain. The journal is in Spanish, but overseas contributions are included.

Revista Iberoamericana de Educación Superior a Distancia. Published each October, February and June by the Asociación Iberoamericana de Educación Superior a Distancia (AIESAD), Universidad Nacional de Educación a Distancia (UNED), Apartado de Correos 50.487, 28080 Madrid, Spain.

IEC News. Published since 1991 by the International Extension College (IEC), Dale's Brewery, Gwydir Street, Cambridge, CB1 2LJ, United Kingdom.

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*Data source: International Centre for Distance Learning.

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